The Taxonomic Significance and Theoretical Origin of Surface Patterns on a Newly Discovered Bivalve Shell Layer, the Mosaicostracum

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(Plates 26 to 38)

INTRODUCTION

The structure of bivalve shells has been studied with the light microscope at magnifications which allow for a point resolution of 0.2 micron. However, structures present in the shell which are consistent at the species level have not been resolved. The body of knowledge gained so far through use of the light microscope has shown that shell structure is taxonomically consistent to varying degrees at the ordinal level (Newell, 1965) and in some cases (i. e. Ostreidae) at generic through familial levels (Gunter, 1950; Carpenter, 1848; Oberling, 1955, 1964; Boggild, 1930).

The two major advantages that the electron microscope technique offers are resolutions in the 10 Å range and replicas that permit observation of finely structured surfaces. Electron microscopic examination and an understanding of calcification in the bivalve shell is still in preliminary phases. The body of knowledge is quite large but only a few of the major problems have been resolved regarding the mechanism of crystal growth and related organic components. Significant new discoveries and concepts of shell formation are still being made. An understanding of the genetic control of the mode and product of calcification may furnish valuable new tools to biology and paleontology in the fields of systematics, ecology, phylogeny and evolution.

Electron microscopic examination of the calcified outer surface in fossil and living bivalve shells has resulted in significant new discoveries concerning bivalve shell structure. These potentially have an important bearing on taxonomy and the interpretation of phylogenetic relationships.

A discrete, previously unknown calcareous layer, the mosaicostracum (Plates 26 to 38), between the ectostracum and periostracum of numerous, if not all Bivalvia, and at least in some gastropods, has been defined and studied in detail on the Tellinidae. In this family, the mosaicostracum is unique in that it displays patterns which are easily recognized and are definitive for each species (Plates 26 to 35). The most cursory examination of areas extraneous of the mosaicostracum shows many additional features of the shell useful in species recognition and possibly new approaches to taxonomic description based on shell structure. In view of the large amount of data that has been obtained, this study is restricted to the mosaicostracum for the present inasmuch as it is apparently the most useful of the valve structures for taxonomic and phylogenetic studies. Other structures were observed in the ectostracum and mesostracum and will be considered in subsequent studies.

Species recognition from the shell, whether it be whole or fragmented, presents a basic problem to the paleontologist and neontologist. The main purpose of this study is to examine the possibilities of species determination based on electronmicroscopic shell structures and to establish control for the investigation of similar shell structures on fossil bivalves. Preliminary investigations indicate the preservation of the mosaicostracum in bivalves at least as old as the Late Cretaceous (Campanian).

This study establishes a technique whereby the malacologist and paleontologist engaged in the study of bivalves can solve problems inherent in the macromorphological approach to taxonomy with the additional information gained by observations with the electron microscope at the ultramicromorphological level. The mosaicostracum and the whole study of microstructure adds a potent new tool to the systematic and phylogenetic study of the Bivalvia.

With the application of modern technology to classical problems in systematics some limit will emerge at which the evidence for species identification is reached. Those faunal elements which form mineralized components have given the systematist a most useful device to decipher the intricate code of evolution. If these mineralized components are studied at the ultramicromorphological level, then the limit of investigation should be the smallest set of organized structures that consistently, at the species level, can aid in a rigorous evaluation of patterns useful to the systematist. The patterns found on the mosaicostracum fit into this realm of evidence.

ACKNOWLEDGMENTS

The author gratefully acknowledges Dr. K. M. Towe of the Smithsonian Institution for the many stimulating conversations and his liberal attitude toward the use of the electron microscope laboratory; Dr. E. G. Kauffman of the Smithsonian Institution for his constant encouragement, criticism and constructive advice; Dr. K. J. Boss of the Museum of Comparative Zoology, Harvard University for his assistance in the taxonomy of the Tellinidae; Dr. Joseph Rosewater of the Smithsonian Institution for allowing the author to use specimens of the Tellinidae in the Division of Mollusks collection; Dr. P. E. Hare of the Geophysical Laboratory, Washington, D. C.; Mr. David Massie of the U. S. Geological Survey for his invaluable aid in many of the problems connected with the photography; Mr. Larry B. Isham of the Smithsonian Institution for his help in preparing the plates; Mr. J. M. Jackson, now a graduate student at Yale University, for suggesting the Tellinidae as a group most fitting for the problem and for many discussions of the biology of modern bivalves.

METHODS

The mosaicostracum was detected when replicas of the outer shell surface of *Brachidontes recurvus* (RAFINESQUE, 1820) were being examined in an attempt to isolate the area of the valve where calcite exists. Initial observations of the outer surface revealed a type of calcification that was not continuous with the underlying shell structures. The nonconformity with the underlying ectostracum and the unique appearance of this layer incited further studies on other species of the family Mytilidae. It appeared that a systematic study of the layer may have implications on the problems of interpreting shell structure as well as a possible tool for the recognition of shell structure differences at the species level.

The family Tellinidae was chosen for a systematic study of the patterns on the mosaicostracum for the following reasons:

1. They are well represented in Recent and fossil bivalve assemblages.
2. They have world-wide distribution. Many species have broad geographic ranges spanning several biogeographic provinces.
3. They are euryhaline, have a depth tolerance from the littoral zone to hundreds of feet and inhabit numerous marine environments (YONGE, 1949).
4. Large, relatively complete collections are in the Smithsonian Institution. These had been utilized in a recent revision of the Tellinidae by Dr. K. J. Boss, Harvard University, and could therefore be relied upon to be taxonomically up-to-date and in good order. Boss's systematics were employed in this study.
5. The species are infaunal and are commonly well preserved in the fossil record. The Tellinidae are therefore a group useful to the geologist in interpreting

Explanation of Plate 26

Plan Views from Pt/C Single Stage Replicas of the Surface of the Mosaicostracum. × 15 000

Figure 1: *Tellina (Tellina) radiata* LINNAEUS, 1758; USNM No. 568232

Figure 2: *Tellina (Moerella) salmonea* (CARPENTER, 1864) USNM No. 108639

Explanation of Plate 27

Plan Views from Pt/C Single Stage Replicas of the Surface of the Mosaicostracum. × 15 000

Figure 3: *Tellina (Laciolina) laevigata* LINNAEUS, 1758 USNM No. 83334

Figure 4: *Tellina (Laciolina) magna* SPENGLER, 1798 USNM No. 36174

Explanation of Plate 28

Plan Views from Pt/C Single Stage Replicas of the Surface of the Mosaicostracum. × 15 000

Figure 5: *Tellina (Phyllodina) squamifera* DESHAYES, 1855 USNM No. 461776

Figure 6: *Tellina (Phyllodina) persica* DALL & SIMPSON, 1901 USNM No. 161780

Explanation of Plate 29

Plan Views from Pt/C Single Stage Replicas of the Surface of the Mosaicostracum. × 15 000

Figure 7: *Tellina (Merisca) cristallina* SPENGLER, 1798 USNM No. 530395

Figure 8: *Tellina (Merisca) aequistriata* SAY, 1824 USNM No. 194658

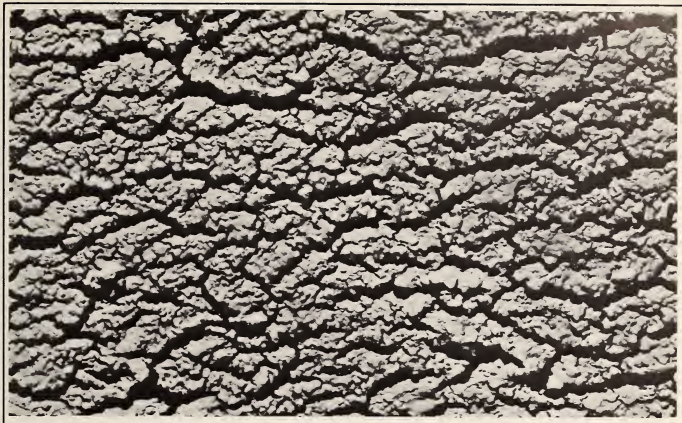

Figure 1

Figure 2

Figure 3

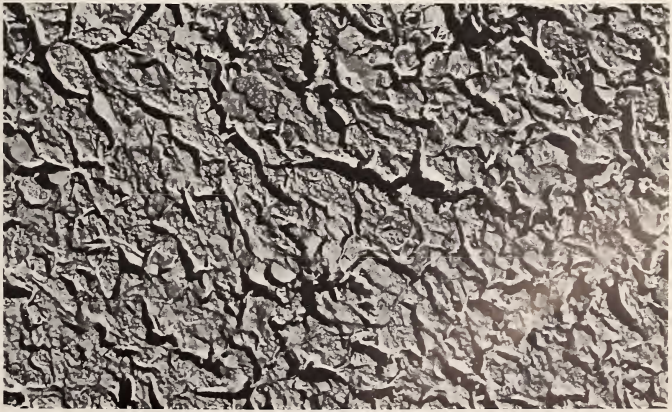

Figure 4

Figure 5

Figure 6

Figure 7

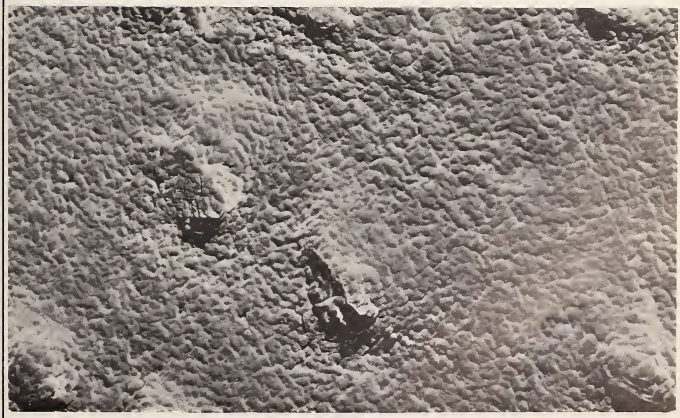

Figure 8